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method of analysis has not been fully decided upon, I am obliged to say that the figures I herewith give may in future require some alteration.

The following table shows results of a preliminary analysis:

EXAMINATION OF TARAXACUM ROOT COLLECTED IN —

	May.	*September.*
Moisture in fresh root, dried at 45° C	81.24 per cent.	73.00 per cent.
Loss in drying, at 100° C	13.45 "	11.79 "
Juice extracted by pressure	57.00 "	very small "
Percentage of solid in juice	1.472 "	.....
Reducible sugar in juice	.036 "	.02052 "

At a future time I hope to be able to verify these figures, and at the same time make a fuller report of all the principal constituents of the root at various seasons of the year.

THE NIOBRARA CRETACEOUS OF WESTERN KANSAS.

BY S. W. WILLISTON, STATE UNIVERSITY, LAWRENCE.

Even an approximately correct map of the outcrops of the Niobrara cretaceous in Kansas cannot be given until they have been systematically surveyed. The overlying tertiary is everywhere unconformable, and is found at varying levels, even within short distances. It is very evident that the main valleys of the region had been eroded before the deposition of the tertiary rocks, and, although the sandstones have been since almost wholly eroded in the valleys, yet they remain in isolated patches over a large part of the Niobrara region.

The most northern exposures of the rocks are said to be on the Sappa, but I have seen them only as far north as the Prairie Dog, where they occur at various places in the immediate river valley from Norton to the State line. On the North Fork of the Solomon the Niobrara reaches nearly to Lenora, though the western outcrops are insignificant. On the South Fork it appears as far west as the extreme western line of Graham county. On the Saline it reaches only a little way into Trego county. By far the greatest amount of exposure is found in the valley of the Smoky Hill, where denuded areas are found quite to the western line of the State. South of the Smoky Hill the exposures are very few.

At another time I shall give more fully the history of the explorations of these regions; at present a brief sketch will suffice. Almost the earliest collections of fossils from this region were made by army surgeons stationed at Fort Hays or Fort Wallace, especially Doctors Janeway and Sternberg.

The next explorer to make any scientific examination of the beds was, I think, Professor Mudge; but the first collections of moment were made by Professor Marsh, with a party of Yale students, who spent several weeks in the vicinity of Wallace, under an escort of United States soldiers, in 1870.

In 1871, Professor Cope made some valuable collections in the same region, an account of which is given in his Cretaceous Vertebrata. Again, in 1872, Professor Marsh with a party spent several weeks, under hardships similar to those of his first expedition, on the upper Smoky Hill. In this and the following season, Professor Mudge made collections in the northern part of the State, among which was the first specimen of a bird showing teeth, which specimen has never been equaled since. All these collections, however, were trivial in amount and value to the extensive collections made during the following four or five years, by parties of which Professor Mudge, H. A. Brous, E. W. Guild, George Cooper, Charles Sternberg and the writer were members.

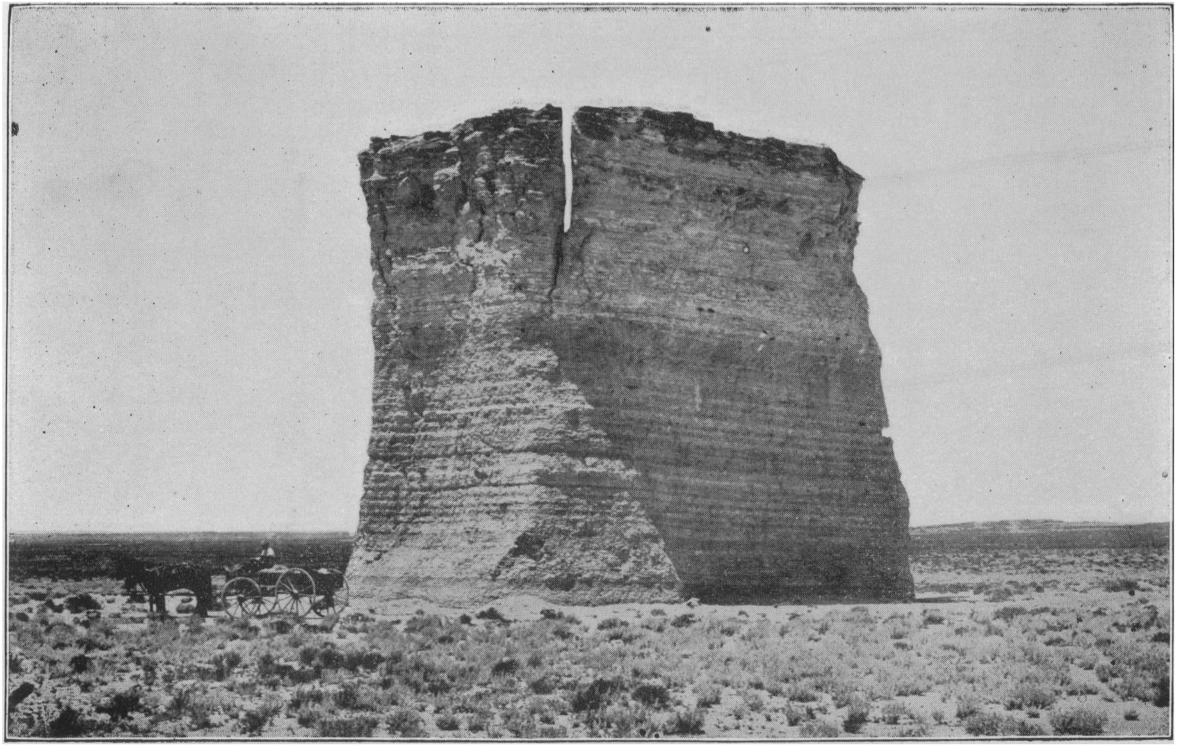
In more recent years, aside from some isolated specimens that have found their way into collections, many interesting specimens have been collected by Professor Snow, the late Judge E. P. West, Dr. George Baur, Charles Sternberg, E. C. Case, and myself. To none of these collectors, however, is so much credit due as to the late Professor Mudge, my teacher and friend. While another, well-known author has recounted the hardships and dangers to which he was subject under the guardianship of United States soldiers, Professor Mudge explored the regions wholly unprotected, where danger from marauding Indians was often imminent. To Mudge is also due the first, and, until now, almost our only published knowledge of the extent and physical characters of the regions explored. Much of the information gathered by him is, from the necessities of the case, incomplete and fragmentary, and in some cases erroneous. There were scarcely any railroads then in the region, and explorations required long and painful travels by wagon and on foot, oftentimes scores of miles from the nearest human settlement. During nearly all the time that Professor Mudge was in these regions, I was a member of his parties, and have since spent some 10 months in similar explorations. I may, therefore, be permitted to offer the following in continuation or correction of what he has published:

The thickness of the Niobrara rocks has been hitherto underestimated. At Elkader, in the valley of the Smoky Hill, in Logan county, repeated observations with a good barometer gave 290 feet between the bottom of the valley and the highest Niobrara rocks underlying the tertiary sandstone. Wells in the vicinity had penetrated at least 40 feet further without passing through the blue chalk, making a total of 330 feet as the observed thickness at this place. From stratigraphical reasons, which will be understood later, it seems certain that at least another 100 feet may be added to this, giving as a minimum 430 feet as the total thickness at this place.

There are many difficulties in the way of an absolutely correct measurement of the outcrops. The rocks nowhere present clear lines of stratification over extended areas. A slight difference in the coloration or the effects of weathering is all that can be relied upon. Further, there are no extended areas of denudation where a true knowledge of the dip can be ascertained, and, in addition, there are numerous local disturbances which interfere with observations on a large scale.

I am satisfied that the dip toward the north or northeast is much greater than has been suspected, save, perhaps, by St. John. The rocks thin out with remarkable rapidity south of the Smoky Hill, and are, I believe, wholly unrepresented south of the Arkansas river. While the rocks in southwestern Trego county are not less than 200 feet thick, in Rush county, 30 miles to the southeast, the tertiary of the tablelands lies immediately upon the Benton. The very characteristic, heavy, stratified chalk, or soft, white limestone, at the base of this formation, about 80 feet in thickness, extends across the State, from near Mankato, in Jewell county, on the north, to north of Coolidge, in Hamilton or Greeley county, on the west. Its character and thickness, wherever seen, are so unmistakable that it is at once recognized. In the vicinity of Hays City, in Ellis county, its elevation is less than 1,900 feet; at the western line of the State, more than 3,400 feet—an increase in 175 miles of over 1,500 feet.

About 50 miles east of north of the westernmost outcrops the uppermost rocks of the cretaceous appear at an elevation of 3,100 feet. But these upper cretaceous rocks at McAllaster are at least 400 feet above the lowest, making a dip, if I am not mistaken, of 600 or 700 feet in the 50 miles. Before this remarkable dip had become evident to me by the discovery of the basal strata in Hamilton county, I had been very much at a loss to account for the marked northern inclination of the stratified, or Fort Hays beds, as I will call them, in Ness and Trego counties. This marked northeastward inclination of the strata has already been spoken of by



SOUTHERNMOST OF THE MONUMENT ROCKS,
NIOBRARA CRETACEOUS, SMOKY HILL VALLEY, GOVE COUNTY, KANSAS.
From a photograph by S. W. Williston.

St. John, in his report for 1885, where he shows that the exposure of the characteristic leaf-bearing Dakota sandstones in the extreme southwest is at least 1,100 feet higher than at Larned, in Pawnee county, or 1,700 feet higher than in Saline county; observations quite in accord with my own.

In Lane county, south of Dighton, on the head waters of the Walnut, I determined the Niobrara cretaceous. In all probability there is a small outcrop of the same on the head waters of Pawnee Fork, and possibly also north of Coolidge. Professor Hay tells me that there is a small outcrop on the White Woman, in Greeley county. I believe that these are the southernmost outcrops of the formation in the State. The Benton probably occurs furthest south in the longitude of Meade county, where St. John and Hay have determined rocks of a more recent age than the Dakota.

There is a very interesting problem in this connection. In Professor St. John's report, he says (page 145) the Niobrara rocks of the southwest "consist of only a few feet thickness, of light, creamy, buff chalky limestones, in rather even layers, from a few inches to a foot thick, and in places charged with Inoceramus problematicus, another large, thin-shelled, undetermined species, and remains of bony fishes, such as characterize the Niobrara formation in the region to the north and northeast. . . . Similar exposures occur on north-side tributaries of Crooked creek, in the southwest part of Ford county. The limestone at the latter localities has also been quarried to a limited extent, and it affords the same species of fossils. These occurrences are identical with those on Sawlog creek, north of Fort Dodge, and in the valley of Pawnee Fork, in Hodgeman county. . . . The heavy limestone deposit that forms the upper horizon of the Benton, of the Smoky Hill, is apparently wanting in this southwest region."

Six miles south of Rush Centre, I found a similar deposit, less than 50 feet in thickness, lying upon undoubted Benton rocks, and covered by the tertiary of the summit of the divide. At the time of my visit, I had no doubts of its Niobrara character, and later Niobrara as well. It showed the same chalky shales, numerous specimens of small shells, and fragments of weathered fish bones. I was exceedingly surprised a few days later to discover the massive, chalky limestone less than 20 miles north, on Timber creek. Further, this limestone undoubtedly occurs on the Walnut; Mudge says that it occurs on the Pawnee, and I found it north of Coolidge. In other words, it runs uninterruptedly through the State, and, without doubt, St. John's outcrop, as well as that of Rush county, are earlier. We have much to learn of the Benton in Kansas, and, I believe, many interesting results to obtain.

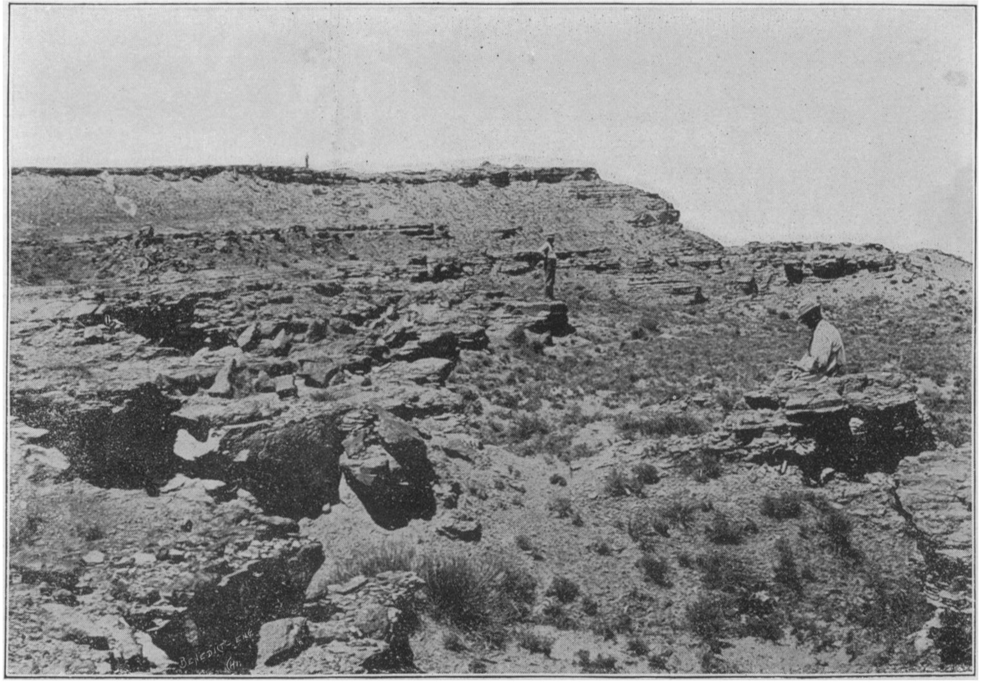
The divisional line between the Benton and Niobrara I take at the top of the stratified beds already mentioned, following Mudge. But I am not at all certain that it should not be placed below this, or even below the subjacent dark-blue shale. Its chief distinction is its firmer texture, its comparative barrenness in fossils, and its well-marked lines of stratification. Its invertebrates are much more like those of the Niobrara than those of the more yellow limestone below. These fossils, however, are much more broken up and much less numerous. Immediately overlying this, and conformable with it, is found the true chalk of the Niobrara. In microscopic structure, the chalk, whether from the highest or the lowest of the outcrops, seems tolerably uniform, and closely resembles the English chalk. The great mass of the material is made up of coccoliths, but with a considerable quantity of both rhabdoliths and foraminifera. In its gross characters, however, there is not a little difference between the upper and lower beds. In the lower portions, the chalk, where exposed, is white or gray, never deeply yellow, and the shales are of a lighter blue. In the upper portion, the chalk is more yellow, and often shows decidedly buff or reddish tints. It is also here smoother and softer to the touch. There is, also, a very marked difference between the upper and the lower beds, in the relative amount and in the kinds of fossil remains. In the very lowest, the exposures are exceedingly barren in vertebrate fossils. A day's search will not reveal a half dozen specimens of any kind. In one day last year, the three members of my party found over 30 saurians, five or six pterodactyls, several turtles, and fishes innumerable, in the upper beds. On the other hand, the invertebrates are here especially numerous, strewing the surface in heaps; large and perfect Haploscaphas, Rudistes, etc., can be obtained literally by the wagon load, while, for the most of them, one would search the upper beds in vain. I have never known any reptilian remains to be found within 100 feet of the base, though, in all probability, some species do occur here. As we go upward, the vertebrates become more abundant, and the invertebrates, save the ostrea and the large, thin-shelled, four-foot inoceramid, and perhaps some others, become markedly less numerous. Among the vertebrates, two of the three genera of the mosasaurs occur throughout, but the third, Clidastes, I have never known to be found save in the upper part. The plesiosaurs are rare everywhere, but relatively more abundant in the lower strata. Of the pterodactyls, the larger species are relatively more abundant below, though absolutely more numerous above. Finally, the turtles are exceedingly rare in the lower parts, but are very commonly met with in the uppermost strata. With two possible exceptions, the birds have never been found below the yellow chalk. This all seems to show that the water gradually became more shallow, and the shore lines less remote, as the formation grew younger.

The horizon of the yellow chalk can be readily traced, from near Monument Rocks on the south, northeastward to the Saline, north of Wa Keeney, and thence to the South Fork of the Solomon, near Hill City. It occurs on the North Fork of the Solomon, east of Lenora, but how much further east I cannot say. Some small outcrops, apparently of the same, I have observed on the Prairie Dog, near Norton.

It will be seen from the foregoing that I admit of no stratigraphical distinction between chalk and blue shale. The difference between these is wholly chemical, and has nothing to do with the geological position. I may add that the rare crinoid, Uintacrinus, which was originally described from Kansas specimens, seems to be confined to one horizon, near the middle of the beds. A large and magnificent slab or plate of these interesting fossils, covering fully 20 square feet, was obtained by our party the past year from the Smoky Hill, near Elkader, and now is one of the treasures of the State University museum.

Some years ago, Professor Mudge discovered, near the old town of Sheridan, a large mass of baculite. On referring specimens of them to the veteran paleontologist, the late Professor Meek, the species was determined as Baculites anceps, with the following remarks, as published by Professor Mudge: "One fact in regard to your specimens, however, is very curious to me. All the other forms like this that I have ever seen from any part of the far West come from Nos. 4 or 5, while all of the species yet known from these upper rocks are distinct from anything found in Nos. 2 or 3. Can it be possible that you might have found this in anoutlier of Nos. 4 or 5? It has the shell substance well preserved, like the fossils of these upper beds, while those in the lower beds are usually casts." Mudge, however, thought that the deposit was clearly Niobrara.

I believe that Meek was right, and that the beds here represented are either of the Fort Pierre group, or transition beds to that group. My reasons are as follows: Not another specimen, so far as I know, of this baculite or of any other has ever been found below this horizon. Furthermore, in a visit to the locality the past year, a careful search did not reveal any other invertebrates known from the chalk below it, but did disclose one or two other mollusks that I have never seen elsewhere in all the years I have spent in this formation. I have not yet had an opportunity to de-



OUTCROP OF NIOBRARA CRETACEOUS CHALK,
PLUM CREEK, GOVE COUNTY, KANSAS.
From a photograph by S. W. Williston.

termine the species, but I confidently expect to find them identical with species from the Fort Pierre group, if not new. Furthermore, of the vertebrates that I know from these beds, all seem different from those of the beds below. One of them I have recently described as Clidastes westii, the most aberrant species in the genus.

Lithologically, the outcrops, which are not extensive, are all of a deep blue color, with numerous and large septaria, in which are found the large and beautiful crystals of baryte. The outcrop occurs at the extreme top of the Niobrara, on the North Fork of the Smoky Hill and in the vicinity of Fort Wallace. The first true Niobrara yellow chalk was observed near the mouth of the North Fork, at an elevation nearly 100 feet below the McAllaster outcrops.

In this connection, it will be of interest to observe that Hay has found "an outcrop in Norton county of two well-marked strata above the yellow chalk," consisting of green sand and green clay shale. (Sixth Bien. Rep. St. Bd. of Agric., p. 103.) Whether or not they belong to an upper cretaceous horizon remains to be shown.

NOTES ON THE ELEMENTARY COMPARATIVE EXTERNAL ANATOMY OF INSECTS.

[For use in entomological laboratory of the University of Kansas.]

BY VERNON L. KELLOGG, UNIVERSITY OF KANSAS, LAWRENCE.

A laboratory course in entomology of 20 weeks, 10 hours' work a week, is offered in the University as a junior or senior optional. Students electing this course have had a 20 weeks' course, 10 weeks of lectures and 10 weeks of laboratory work for 10 hours a week, in general zoölogy. The object of the course in entomology is to train the student in accurate work in anatomical detail, and to give him a knowledge of insect anatomy upon which further work in the comparative anatomy of insects or the determination of species may be based.

A very excellent laboratory guide for this course is that begun by Prof. J. H. Comstock, of Cornell University, and by him called (A Fragment of a) Guide to Practical Work in Elementary Entomology. This guide covers, in careful detail, the external anatomy of the common red-legged locust (*Caloptenus femur-rubrum* De Geer). As a continuation of similar work in external anatomy, I have prepared some laboratory notes (printed as a pamphlet of 12 octavo pages) entitled as at the head of this paper, and comprising anatomical notes on the following subjects: The head and thorax of the milkweed butterfly, *Danais archippus* Fabr.; the mouth parts of the honeybee, *Apis mellifica* Linn.; and the pleural sclerites of the rummaging ground beetle, *Calosoma scrutator* Fabr. The nomenclature of aspects and directions used is that adopted by Professor Comstock (after Professors Wilder and Gage, Cornell) in his "Guide."

In the "Notes" issue is taken with Burgess's statement (see his Contributions to the Anatomy of the Milkweed Butterfly, *Danais archippus* Fabr.) that the clypens of *archippus* "passes directly into the epicranium without any suture or line of demarcation." A suture extending between the antennary fossæ separating clypens from epicranium is plainly to be made out. The patagiæ of the thorax of *archippus* are found to be outgrowths of the meso-thoracic paraptera. The meta-thoracic paraptera are also described. The peculiar shape of the epicranium, accommodating itself to the overlarge compound eyes, is described, and the occiput, gula and labium are described, all of which are points untreated by Burgess.